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ADDITIONAL DEVELOPMENT FOR

CACHE MARKER SYSTEM

CONTRACT NO.

25 November 1952

WASHINGTON

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50X1

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PROPOSAL FOR
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I. Introduction

☐ has completed an initial experimental program for the develop- 50X1
ment of a cache marker system. This system consists of a transponder
which is buried (or submerged) in the vicinity of the cache and a
detection system which is capable of revealing the exact location of
the transponder and thus the location of cache.

The originally suggested requirements which the system must
satisfy are as follows:

- a. The system shall include everything necessary to
attain the desired result including a transponder and a
means for detecting its location under specified conditions.
- b. The system shall be capable of revealing the exact
location of the transponder when searching is started at a
radius of at least 15 feet when the transponder is buried
(or submerged) at a depth of 5 feet below the surface of
the ground (or water). If this depth cannot be realized,
then the depth at least shall be inaccessible to the con-
ventional mine detector. This is presently estimated to
be about 2 feet.
- c. The system shall operate reliably in all varieties
of soil and under water.
- d. A single technique of universal application is
desired.

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- e. The system shall be secure to the greatest extent practicable, from ordinary attack and from accidental disclosure of the cache.
- f. The system shall be operable by non-technical personnel.
- g. The transponder shall be relatively inexpensive.
- h. The transponder shall be passive.
- i. The transponder shall be of construction estimated to operate reliably 5 to 10 years after being placed as specified in requirement b.
- j. The detection device shall be readily portable by one man and capable of operation without apprehension by a casual observer.

As a result of the investigations of Phase I, wherein two basic systems have been devised capable of satisfying the requirements for the cache marker system, the following program for Phase II is proposed:

II. Objectives

- a. To develop and construct a prototype model of the transponder employing production fabrication techniques where necessary to evaluate the feasibility of the component.
- b. To develop and construct a prototype model of the detection device employing production fabrication techniques where necessary to evaluate the feasibility of the component.
- c. To present estimates for construction of production models.

III. Systems to be Evaluated

A. Detection Systems

The following detection systems will be engineered and compared for production and operational practicability. They are discussed in detail in paragraph IV, below:

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1. CW systems where the transmitter output is an unmodulated ac magnetic field and the receiver detects voltage induced in the receiver loop caused by circulating current induced in the transponder.

a. Crossed Coil System

b. Two coil floating receiver system.

2. A pulsed system, wherein the transmitter output is pulsed, the receiver is cut off during transmission and only receives the voltage caused by "ringing" in the transponder.

B. Transponder

The transponder, consisting of a single tuned coil will be engineered for maximum production and operational practicability.

IV. Details of Proposed Systems

The cache marker systems proposed are single-frequency systems operating at frequencies from 50 to 150 KC. Two-frequency systems were considered during the experimental program of Phase I and no two-frequency system was found which could not be detected by a single-frequency detection device.

A. Crossed-Coil Detection System

The CW crossed-coil system consists of a transmitter and receiver which cover the frequency range of 50 to 150 KC, and a tuned transmitter loop and tuned receiver loop, arranged as in Figure 1.

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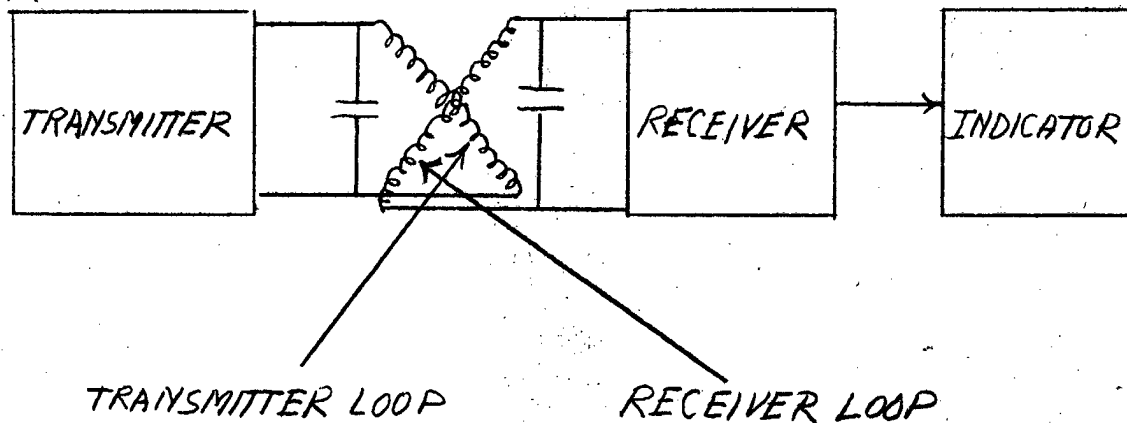


Figure 1.

The transmitter consists of an oscillator driving a power amplifier whose output is fed to a parallel tuned circuit. The amplified receiver loop output is fed to an indicating device. The transmitter and receiver loops are oriented for minimum direct coupling between the two. The transponder, which is the same for all systems proposed, simply consists of a tuned LC circuit. The alternating magnetic field produced by the transmitter loop induces a circulating current in the transponder. The alternating magnetic field produced by these transponder currents induces a voltage in the receiver loop. This voltage is amplified by the receiver and fed to the indicator, which gives an aural or visual indication proportional to the received signal strength, i.e. proportional to transponder and detection device.

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B. Floating Receiver Detection System

The CW, two-coil floating receiver system uses the same loop for transmitting and receiving, in the manner shown in Figure 2, below:

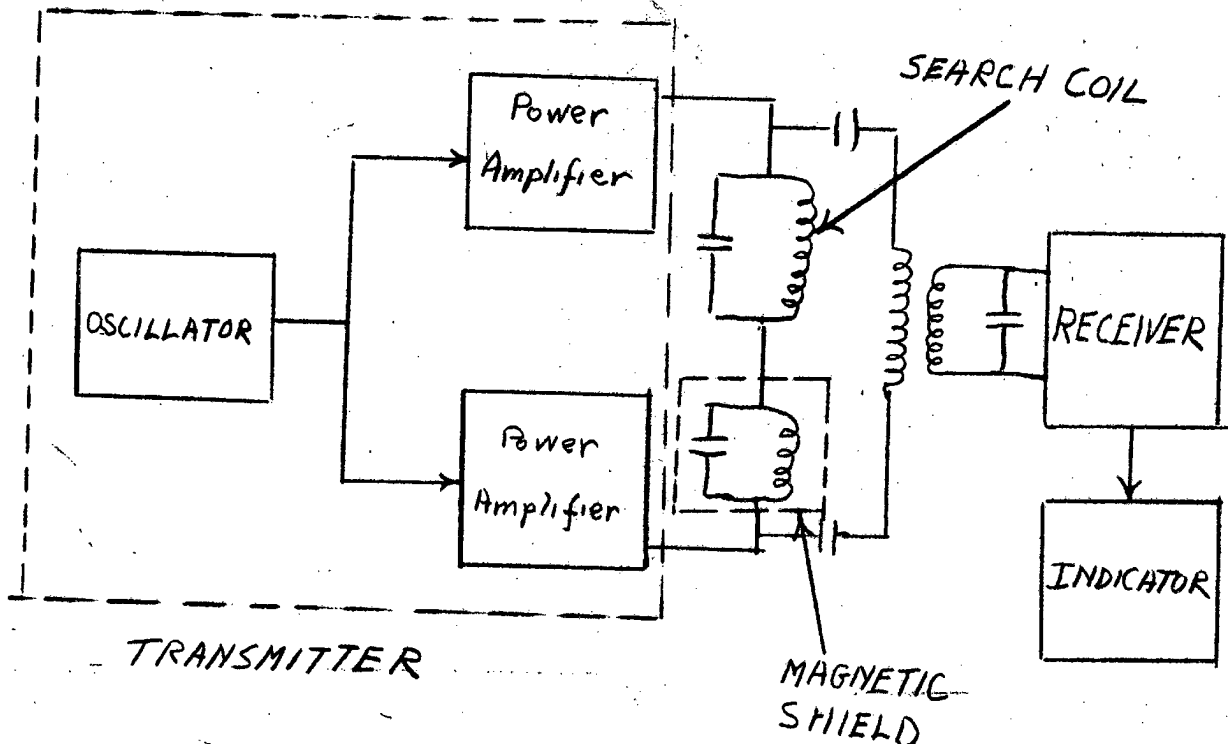


Figure 2.

The transmitter for this system consists of an oscillator driving two power amplifiers which in turn feed two tuned circuits. The upper tuned circuit (search coil) is not magnetically shielded, its magnetic field is radiated. The circulating current thus induced in the nearby transponder produces a magnetic field which is able to re-induce a voltage in the search coil. The lower tuned circuit is completely shielded and produces no external fields.

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The phase and amplitude of the voltages across each tuned circuit are adjusted for minimum input to the receiver, when no transponder is present. The receiver is identical to that used in the crossed coil system.

The operation of this system is as follows: The alternating magnetic field of the unshielded coil induces a voltage in the transponder which in turn produces an alternating magnetic field. The transponder's field re-induces a voltage in the search coil of the detection system. This voltage upsets the previously established balance, producing a signal input which is detected and amplified by the receiver and fed to the indicator.

C. Pulsed Detection System

The pulsed system employs a pulse-modulated transmitter, a gated receiver with an untuned input (to prevent "ringing"), and a gate-pulse generator to synchronize the transmitter and receiver.

See Figure 3, below:

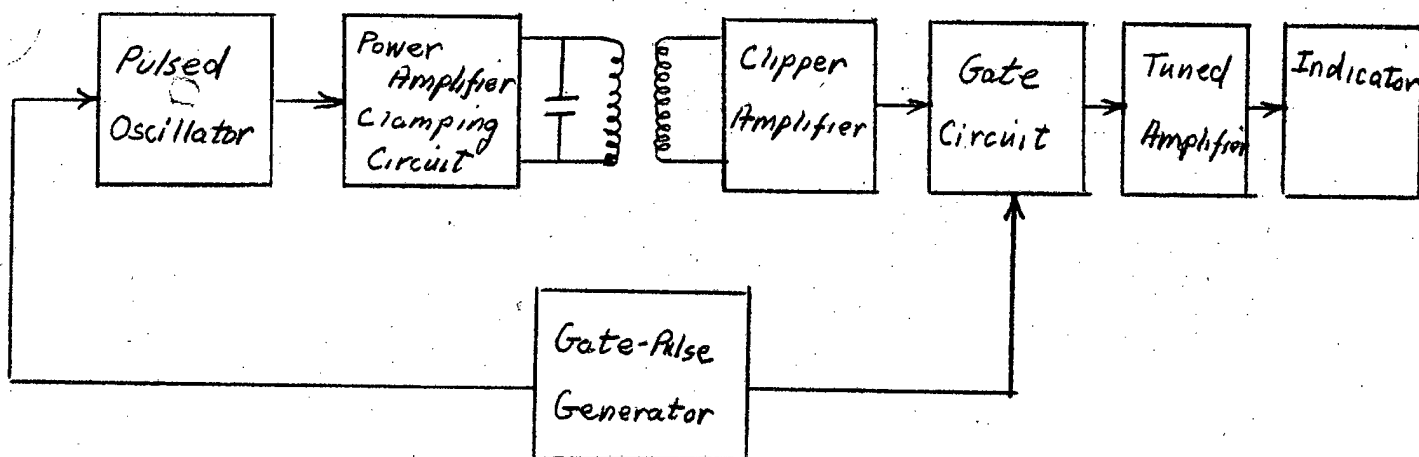


Figure 3

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The pulse modulated transmitter consists of a pulsed oscillator which oscillates only during the duration of a negative pulse supplied by the gate-pulse generator. The oscillator drives the power amplifier clamping circuit which amplifies the oscillator output feeding the tuned circuit. At the end of the pulse supplied to the pulsed oscillator, the power amplifier clamping circuit automatically places a large load across the tuned circuit which decays the oscillating current in the tuned circuit to zero in a few cycles.

The receiver's input is untuned and contains a clipping circuit which reduces the signal to about 1 volt, peak-to-peak. This is followed by an untuned stage of amplification and further clipping. This process is repeated twice, which brings the amplitude of the signal from the transponder up to the level of the signal received directly from the transmitter. The output of the last clipper amplifier is fed to a gate circuit which is controlled by a pulse from the gate-pulse generator. The gate circuit allows a signal to reach the following tuned amplifiers and indicator except when the transmitter is on and for a short time after, to prevent the decaying signal from the transmitter from getting through to the indicator.

The transponder is a high-Q tuned LC circuit which "rings", i.e. the current continues to oscillate after excitation from the transmitter ceases. It is the voltage induced in the receiver coil by "ringing" in the transponder which is permitted to reach

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the indicator.

D. Transponder

The transponder, which is to be the same for all systems, will consist of a high Q coil and condenser circuit. As presently envisioned, the transponder will be made in different sizes ranging from about 9 to 18 inches in diameter and covering the frequency range of 50 to 150 KC with the larger coils being used at the lower frequencies. In order to obtain the necessary high Q coils, Litz wire will be used in a honeycomb or space-wound construction. The coil and condenser will be imbedded in a weather-resistant plastic for mechanical and electrical stability as well as for protection from water, moisture and the effects of extreme temperatures.

IV. Cost and Time Estimates

It is estimated that the Phase II program outlined above can be accomplished on a cost plus fixed fee basis within a period of from 10 to 12 months, depending on the degree of success achieved during the early part of the work, delays experienced in procurement of material and service, and the date on which it becomes possible to assign to this work the full working group outlined below.

The amounts listed under Subcontracting and Materials below include only such expenditures as can be presently be envisioned. It should be recognized in a program of this nature that unusual techniques, materials, and equipments may be required from time to time in order to insure achievement of the objective. It is expected that such materials and equipments will be supplied as Government-furnished material where possible.

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It is presently believed that the proposed work can best be accomplished in accordance with the following schedule of labor, burden and direct charges, based on a one-year duration:

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